

Appln No. 10/625,834

Amdt date February 22, 2005

Reply to Office action of October 21, 2004

Amendments to the Specification:

Replace paragraph 5, beginning at line 30 on page 5 as follows:

In another aspect of the invention, the surface-based craft further includes an instrument suite and the program instructions for generating a path for the surface-based craft further include receiving surface-based information collected from the instrument suite by the craft, transmitting the surface-based information from the craft to the tracking and command system, and generating a path for the surface-based craft using the surface-based information and the image.

Replace paragraph 2, beginning at line 6 on page 14 as follows:

As depicted, the multi-agent autonomous system is a multilayered and hierarchal system. For example, the surface-based craft constitute one layer, the tracking and command system constitutes another layer, and the satellite constitutes yet another layer. Each layer provides both information inputs from specific instrument suites and also includes computational elements. The exact distribution of the instrument suites, computational elements, and even the number of layers may be altered. For example, an extra airborne layer may be added to command the tracking and command system to relocate. In addition, the computations performed by the tracking and command system may be performed by a surface-based craft or base station. Finally, the satellite may be used to track and

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command the surfaced-based craft without having in intervening airborne instrument[[ed]] or processing element.

Replace paragraph 2, beginning at line 24 on page 14 as follows:

FIG. 3 is a block diagram of a surface-based agent or craft in accordance with an exemplary embodiment of the present invention. A craft 102 includes a controller 300 having programming instructions 301 for controlling the operation of the craft. The controller is coupled to a transceiver 302 and antenna 304 for receiving and transmitting signals 302 from a tracking and command system. The controller is further coupled to an instrument suite 204 (or "sensor suite") used to analyze the craft's environment. The sensor suite may include imaging sensors such as video cameras for capturing images of the environment for transmission to the tracking and command system.

Replace paragraph 1, beginning at line 3 on page 17 as follows:

FIG. 5 is a software module diagram of a multi-agent autonomous system in accordance with an exemplary embodiment of the present invention. The tracking and command system includes a communications module 500 for receiving commands from a satellite or other external system. Once an initiate signal is received, the tracking and command system uses an overhead image capturing module 501 to capture an image of an operational area. The image 502 is transmitted to a reconnaissance craft position module 504. The reconnaissance craft position module used the image to determine the location and heading 506 of a surface-based craft in the area of operation. The image is further used

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by an imaging processing module 512 to identify any obstacles that may be in the area to be explored by generating a set of obstacle coordinates and outlines or edges 514. A processed image 516 from the image processing module is transmitted to a feature detection module 518. The feature detection module uses the processed image to demark image features 520 that are transmitted to a reconnaissance and target identification module 522. The reconnaissance and target identification module identifies features of interest in the operational area. Those features of highest interest are identified as targets and a set of target positions 523 is generated.

Replace paragraph 2, beginning at line 9 on page 17 as follows:

A path planning module 508 receives the reconnaissance craft location information 506, the obstacle location and edge information 514, and target positions 523. The path planning module uses this information to plan a path for the craft and generate a set of craft commands 524. The tracking and command system then uses a craft communication module 526 to transmit the craft commands to a craft.

Replace paragraph 3, beginning at line 31 on page 17 as follows:

The path planning module forwards the craft's instrument suite information 530 to an in-situ instrument measure module 532. The in-situ measurement module analyzes the information received from the surface-based craft and forwards the resultant measurements 533 to an intelligence reconnaissance output module 534. The intelligence reconnaissance output module transmits

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the craft information to external entities for integration into a previously described database 122 (of FIG. 1b).

Replace paragraph 2, beginning at line 32 on page 19 as follows:

FIG. 7b is a semi-schematic drawing of a craft, targets, and obstacles identified in an environment by a craft tracking and command system in accordance with an exemplary embodiment of the present invention. The tracking and command system identifies the craft 702 in the image by extracting features from the image and analyzing the features. Once the tracking and command system has identified the craft, as exemplified by the box 712a, the tracking and command system can determine the craft position. In addition, the tracking and command system uses the indicia on the craft to determine the heading of the craft.

Replace paragraph 1, beginning at line 3 on page 20 as follows:

The tracking and command system also separates other features within the image into obstacles and targets. A target may be separated from an obstacle by considering a feature space including the object's size, shape, albedo, surface irregularities, etc. Once an object has been identified as a target, as exemplified by box 712b around target 710a, the tracking and command system can determine the target's position. The tracking and command system continues processing features in the image to identify other targets, such as target 710b, as exemplified by triangle 712c. Other features identified by the

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tracking system, such as features 704a, 704b, and 704c, are identified as obstacles to be avoided by the craft.